

AFIT/GCA/LAS/97S-4

THE DETERMINANTS OF THE HOUSING
CHOICES OF MILITARY FAMILIES:
IMPLICATIONS FOR MILITARY POLICY

THESIS

William R. Forster, First Lieutenant, USAF

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THESIS

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and Acquisition Management of the Air Force Institute of Technology

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Degree of Master of Science in Cost Analysis

William R. Forster, B.S.

First Lieutenant, USAF

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Abstract

The Department of Defense (DOD) currently spends \$8.2 billion dollars a year on military housing and housing allowances and yet there is no empirical model of the housing choices that military families make. This thesis creates a model of the housing choices of military families and then uses the model to predict the effects that changes in several policies would have on the housing decisions of military families. The changes in housing choices are then combined with current 1997 force structure data to predict both the monetary costs and benefits of each policy change.

Data from the 1992 Surveys of Officer and Enlisted Personnel and Their Spouses are weighted to reflect current force structure levels and are used with the multinomial logit technique of maximum likelihood estimation to develop a model that both gives insight into what factors influence military families' housing decisions as well as how policy changes would affect those housing choices. In particular, changes in policies pertaining to tour length, military pay, and closing costs are investigated

The results from the analyses can assist DOD leadership in making decisions that could save millions in housing costs each year. For example, this thesis indicates that an increase in the average tour length for military personnel by one year could save 118 million dollars per year in housing costs. Furthermore, an increase in military compensation would save significant amounts of housing funds. Finally, if the military were to pay the transaction costs associated with home sales the homeownership rate

would nearly double and the military would recoup two thirds of the funds spent in such a program through decreased military family housing expenses.

THE DETERMINANTS OF THE HOUSING CHOICES OF MILITARY FAMILIES: IMPLICATIONS FOR MILITARY POLICY

I : Introduction

The United States Military has experienced large budget cuts since the end of the Cold War and the subsequent fall of the Berlin Wall. Budget pressures, along with the need to modernize and invest in infrastructure, leave the Department of Defense in a search for funds. The tight defense budget comes at a time when quality of life issues are at the center of the administration's and public's concerns. The thought of American fighting men and women being deprived of the quality of life that they deserve has brought plans from all agencies as to how to improve the soldier's quality of life. The only problem with most plans is the monetary cost to implement them; this money is just not available. Military housing is currently an area of concern and of high spending¹. By analyzing the housing habits and desires of Department of Defense military members, it is possible to make changes that will both save the government money, and give the soldier, sailor, or airman more choice of housing and a better quality of life.

This thesis uses data from the 1992 Surveys of Officers and Enlisted Personnel and Their Spouses to develop a multinomial logit model of the housing choices of

¹ In September, 1996, the General Accounting Office released a report titled "Military Family Housing: Opportunities Exist to Reduce Costs and Mitigate Inequities." The report highlighted the need for "information to better quantify the relationship between quality of life and family housing ... reflect(ing) service members' desires and preferences for private versus public housing" (GAO, 1996: 44).

military couples that live in the continental United States. The housing choices examined are; live on in military housing, rent, or own. The model is, in turn, used to investigate the how changes in military policies could affect housing decisions. Policy changes are subjected to cost benefit analyses and recommendations based on these analyses are made.

Present DOD Military Family Housing Situation

As the Department of Defense (DOD) attempts to accommodate the massive budget cuts accompanying the end of the Cold War, it looks to housing as a potential area for savings. Indeed, in FY1996, DOD spent \$3.8 billion to maintain its current inventory of housing and to construct new dwellings (The Budget for Fiscal Year 1998). Another \$4.4 billion went to DOD families in the various forms of housing allowances (GAO, 1996: 2). DOD budgets substantial expenditures to give those who serve in the military adequate housing.

DOD currently provides 293,100 families with government housing and gives housing allowances to another 605,300 (GAO, 1996: 11). Two separate DOD agencies are responsible for managing the housing needs of the military. The office of the Under Secretary for Acquisition and Technology manages government provided housing, while the office of the Under Secretary of Defense for Personnel and Readiness is primarily responsible for housing allowances (GAO, 1996: 12).

The funding and control structure for housing allowances and housing maintenance and construction funds is also split. Military family housing (MFH) funds are from a different appropriation than are military pay funds. Military housing

allowances are governed by higher authorities, and are uncontrollable by local commanders. However, occasionally base operating and maintenance funds can be used to bolster military family housing.

Even though two-thirds of families live in private housing and draw housing allowances, government housing still constitutes 46% of total housing related expenditures. Three estimates have been conducted in the recent past addressing the question of exactly how much more expensive military family housing is than civilian housing. The first such study was the 1993 Congressional Budget Office report titled "Military Family in The United States." This report concluded that it costs on average \$5,500 more (in 1993 dollars) to house a military family in government quarters than it does to provide a housing allowance for the family to secure private sector housing (CBO, 1993: 18). This difference is partially caused by the school impact aid that the military must pay to local schools to offset the cost of schooling for each child who lives in government quarters. On average the military subsidizes local schools with \$1,900 for each student child who lives in government quarters, because the government does not pay property taxes (CBO, 1993 :18). Service members who live in private housing pay, on average, \$1,700 out of their regular pay for housing (CBO, 1993 :18). The remaining difference of the costs for military and private housing may be attributable to costly maintenance practices, administrative costs associated with government activities, or the higher specifications at which government quarters are built (GAO, 1996: 17).

In response to the CBO report, the Department of Defense conducted its own study in 1994. In this analysis, DOD changed some assumptions, did not include the implicit value of land, and concluded that the difference in cost for government and

private housing was \$3,181 (1994 dollars) per family (GAO, 1996: 16). Although the difference was less than the CBO study, DOD still concluded that it was significantly more expensive to house a family in government quarters.

The third and most recent study focusing on the cost comparison of military and private housing was conducted by the General Accounting Office (GAO) in September of 1996. The GAO estimate was more in line with the Congressional Budget Office and was \$4,957 (1996 Dollars). The estimate was based on actual expenditures for fiscal year 1995 and DOD estimates for the costs of capital investment, school impact aid, and referral services (GAO, 1996 :17-18). The results of all three studies are summarized in table 1.

Table 1: Difference in Private and Military Housing Costs

	1993 CBO	1994 DOD	1996 GAO
	<u>Study</u>	<u>Study</u>	<u>Study</u>
Cost of Government Housing Unit	\$13,000	\$10,786	\$12,373
Cost of Private Housing Allowances	<u>\$7,500</u>	<u>\$7,605</u>	<u>\$7,416</u>
Difference	\$5,500	\$3,181	\$4,957

All three analyses conclude that government housing is more expensive than private sector housing. The Department of Defense acknowledges this fact by its policy to rely on civilian housing when available. If employed, this policy could reduce overall housing costs, but in the 1996 report, the GAO concluded that the policy was not being followed (GAO, 1996: 19). The reluctance to rely on civilian housing comes partly from the fact that the military professes that the quality of life is higher for families in government housing. It cites the lengthy waiting lists for on base quarters as an indication that people would rather live in government housing than receive an allowance for private housing. Independent studies have found "little quantifiable evidence that

supports the view that quality of life is better served through military housing (GAO, 1996: 25)". The 1996, GAO report hypothesized that the high demand for government housing is a function of the necessary out-of-pocket housing costs paid by a military member to live in private housing, but that can be avoided in government quarters.

Not only is military housing relatively more expensive, it is also old and in need of renovation. Two thirds of the existing housing units were built in the first years of the Cold War (CBO, 1993: 24), and over 200,000 housing units do not meet minimal standards and are in need of renovation, major repair, or replacement (GAO, 1996: 2). In 1991, DOD estimated that approximately \$60,000 would be required to renovate a single housing unit, and \$100,000 would be needed to replace a dilapidated home (CBO, 1993:24). The longer revitalization efforts are postponed, the greater the risk of increased renovation costs due to continually worsening structural conditions (CBO, 1993: 25).

Major Research Questions

There are several major research questions that this study will answer. In particular, a model will be constructed to study and predict housing choices of military families. This model will aid the Department of Defense in future housing and other policy decisions. The 1996 General Accounting Office study recommended the development of such a model and DOD concurred that it was needed (GAO, 1996: 44). Once a model is constructed, it will be used to address additional research questions.

Three main research questions will be addressed:

1. How would changing military pay affect housing choice?

- Should military pay policy be changed?

- What would be the costs & benefits?
2. **What effect on housing choice would changing tour length have?**
 - Should military tour length policy be changed?
 - What would be the costs & benefits?
 3. **What impact would eliminating transaction costs have on housing choice?**
 - Is it economical to reimburse real estate transaction costs?

Outline of Upcoming Chapters

Chapter two presents information on the history of military housing policy. It investigates both the history of military family housing and the history of housing allowances. The demographics of the families housed in military quarters is also addressed. Chapter three describes the variables used in the model of housing choice and discusses the techniques used in the model formulation. The fourth chapter introduces the data used and describes the variables needed for the estimation. The fifth chapter introduces the model used to predict housing choice and uses the model to conduct sensitivity analyses of policy variables. Cost considerations of potential policy actions are examined.. The last chapter summarizes the results of this study and recommends future actions and research.

II : Military Housing Policy

History of Military Family Housing

The military has always felt an obligation to provide housing for its members, and its members' families. Military family housing policy in America has undergone many changes, as have the actual housing units. Military housing has existed since the conception of the American army, and continues to be an important part of many military members' lives.

Prior to the cold war, the military provided family housing primarily to its officers. The early United States subscribed to the policy of a citizen militia that could be rapidly mobilized to counter any threat to national security. This necessitated a very small core of officers who served on military bases required housing for their families. The enlisted men who served during this time were not expected to have families, and were housed in barracks. During times of war when married men were drafted, they were expected to leave their families while they served (CBO, 1993: 2). This force policy required little in terms of military family housing.

During World War II, the United States saw an unprecedented increase in the size of its armed forces. After the Japanese were defeated in 1945, the threat of communism, and the defense policy of containment required a change in force structure. Gone were the days of the small core of an active duty force; a much larger military was needed to counter the threat of communism. This larger military along with changes in the demographics of the average military member, required new personnel policies which drove changes in the military housing inventory.

Just as the defense force increased in size after World War II, the percentage of servicemen who were married rose. Enlisted men and officers alike could not be expected to serve for long periods of time during the Cold War and to leave their families behind. The change in the size of the national defense force, along with the increased number of married service members, necessitated a buildup of military housing. The Works Progress Administration built a modest number of homes in the 1930s, but the Wherry Housing (construction) Program of the 1950s truly started the trend to increase the number of on-base military family housing units. The largest buildup of housing is attributable to the Capehart Housing program which began building units in 1954 and continued until 1966 (see figure 1). The transition to an all volunteer force in the early seventies brought about yet another housing construction program and the defense buildup of the 1980s saw the last of large scale military housing construction.

In the forty years following World War II, 97% of current military housing was built, DOD became “the nations largest landlord, owning or leasing more than 300,000 family housing units (CBO, 1993: 2)”. Figure 1 from the CBO Study “Military Family Housing in the United States” graphically shows the number housing units (in thousands) constructed each year since 1930.

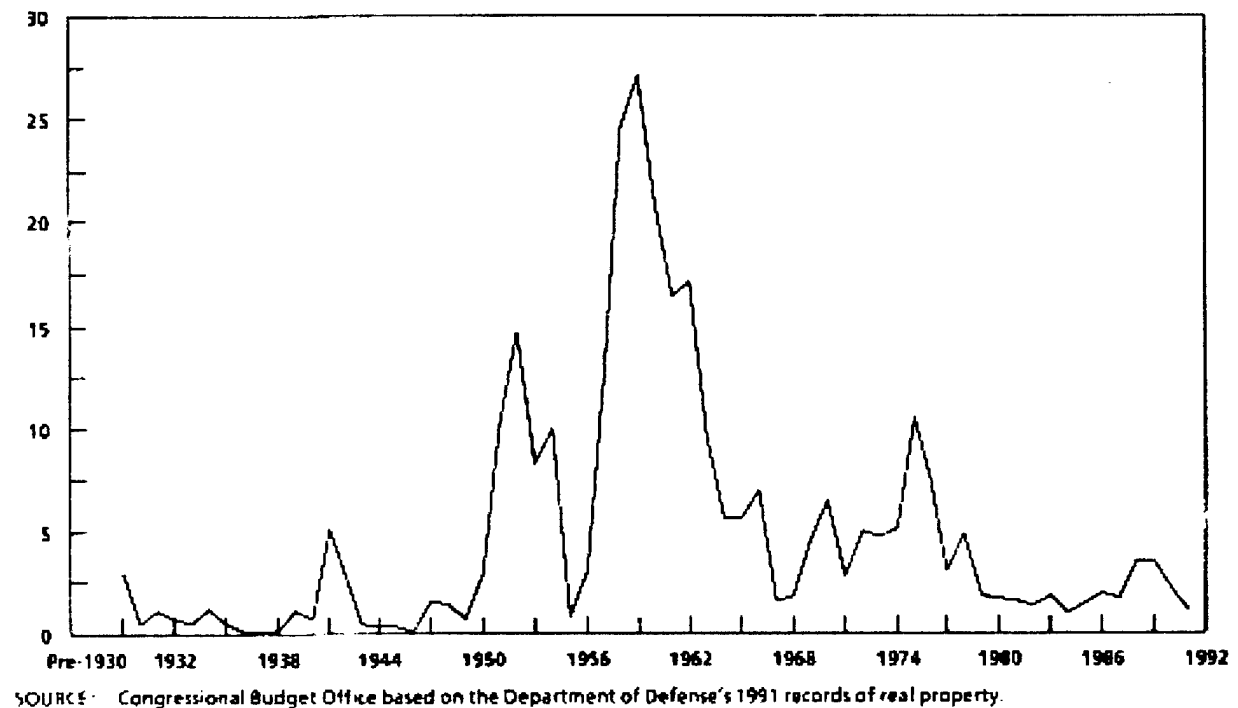


Figure 1: Military Family Housing Construction

Military Housing Location. All primary military installations located in the United States possess DOD family housing. The housing units are disbursed in conjunction with the location of military families. Half of all military families (and DOD family housing units), can be found in seven states (California, Texas, Florida, Virginia, Georgia, North Carolina, and Hawaii). The remaining half are spread throughout the country. Eight states possess less than 1,000 units (Iowa, Minnesota, New Hampshire, Oregon, Vermont, West Virginia, Wisconsin, and Wyoming) (CBO, 1993: 3). The following figure taken from a 1993 Congressional Budget Report illustrates the geographic distribution of our nations military housing (CBO, 1993:6).

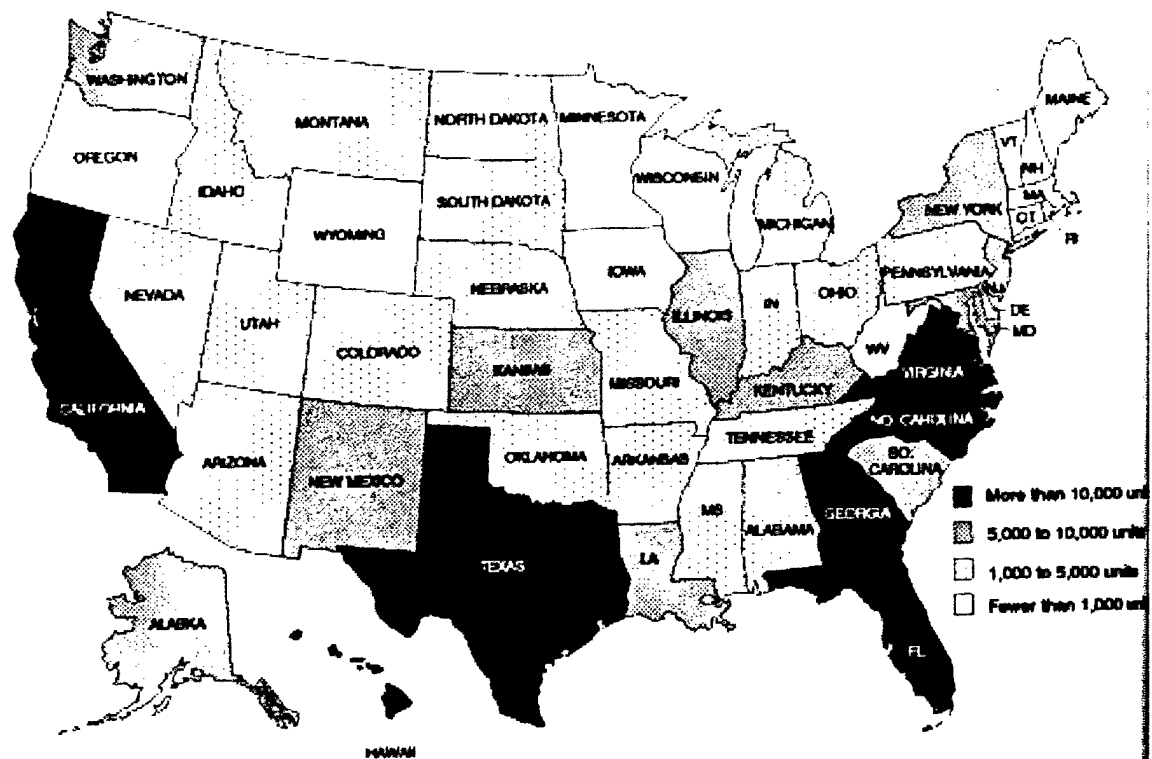


Figure 2: Location of Military Housing

The Congressional Budget Office, utilizing data from over 300 military housing sectors in the United States, determined that the number of military housing units is in direct proportion to the number of military personnel in an area. It also concluded that the ratio of military housing units to military families decreases in areas of high civilian housing availability or low civilian housing costs (CBO, 1993: 4). This data confirms the effect of the DOD's published policy of relying upon civilian housing sources when the local housing community can support the extra demand associated with military installations (GAO, 1996: 3).

Housing Residents. The percentage of military members that reside in government quarters varies among the services. The Army and Air Force house 34 percent of their families in military housing, while the Navy and Marine Corps rely more heavily on the local economy with 20 and 29 percent respectively in government housing (CBO, 1993: 5). The 1992, CBO report on military housing suggested that the long deployments of Naval and Marine personnel along with the increased availability of civilian housing in coastal regions, led to the lower percentages for the Navy and Marine Corps (CBO, 1993: 5). Officers and enlisted personnel alike utilize military housing, although actual housing availability is a function of both military rank and family size.

For many years after World War II, and until the mid 1980's, DOD practice and policy made it difficult for families below the rank of E-4 to get military housing. Recent emphasis on providing quality housing for all grades has reversed this inequality. Currently only 18 percent of government housing is designated for allocation to officers (GAO: 5). This re-allocation has contributed to the dramatically increased wait times for officers to live in military housing; waits at some locations routinely stretch past a year.

History of Housing Allowances

During the early years of the Cold War, DOD planned to construct enough housing units to be able to house all military families. Until enough housing units could be built to satisfy the demand for housing, DOD enacted a housing allowance system to pay a service member's off-base housing costs. This early form of housing allowance was meant to compensate the member for the expenses he incurred until base housing became available. It was only meant to be used as a stop-gap measure until sufficient

military housing would be available for all families.

The housing allowance system was expanded when it became evident that the housing buildup was not going to satisfy 100% of the housing demand, and in 1949, the Career Compensation Act established the basic allowance for quarters (BAQ) system (CBO, 1993: 8). BAQ is based on a member's pay grade and whether or not he has dependents. BAQ is not subject to federal, state or local taxes. It is location independent, and is paid to all military members that do not occupy government owned or leased housing. 1997 BAQ rates are shown in table 2.

Table 2: 1997 Basic Allowance for Quarters

(Monthly In Dollars)		
Grade	Without Dependents	With Dependents
E-1	202.50	361.50
E-2	227.10	361.50
E-3	279.60	379.80
E-4	285.00	408.00
E-5	327.60	469.20
E-6	355.20	21.70
E-7	392.40	564.60
E-8	459.30	608.10
E-9	500.40	659.70
O-1	361.50	490.50
O-2	429.30	548.70
O-3	541.20	642.60
O-4	675.30	776.70
O-5	728.70	881.10
O-6	756.60	914.10
O-7	824.70	1,015.20

The fact that differing geographic locations can have substantially different housing costs led Congress to enact a variable housing allowance (VHA). VHA was established in 1980 to compensate military members for regional differences in housing costs. The amount of VHA one receives is determined by a formula that uses actual

median housing expenditures for each rank in each Military Housing Area (MHA). An MHA is defined as “the geographic area that encompasses all public and private housing within 30 miles, or within a 60 minute commute, of a military installation (CBO, 1993: 4).” VHA was designed to equalize out-of-pocket housing costs between MHAs.

The actual VHA calculation is based on actual housing expenditures. Military members are required to report yearly the amount of their rent or mortgage payment. This mortgage payment is combined with an average area utility cost and is considered the total amount that a military family spends on housing. This data is segregated by rank and the median for each rank is established. VHA is then calculated such that when BAQ and VHA for each rank within an MHA are combined, the amount will equal seventy five percent of the median housing expenditure for that particular rank and MHA (Hunter, 1997: 62).

In 1985, Congress changed the VHA policy to include an *offset* that reduces a recipient’s VHA by fifty cents for every dollar spent on housing less than the member’s housing allowances (BAQ and VHA combined). Any member that spends less than the maximum VHA on housing, will receive a *cut* in VHA actually awarded. Some MHAs have such a low cost of living that no VHA may be paid to some ranks (CBO, 1993: 8). Military families that live in military family housing are required to forfeit all housing allowances (BAQ and VHA).

Also in 1985, Congress established the goal of providing housing allowances such that, on average, housing allowances would cover 85% of housing costs incurred by military families. The goal was not achieved; today the average family is reimbursed 80% of their housing costs (CBO, 1993: 8).

This chapter described the history of military family housing and military housing allowances. Chapter three discusses the theoretical basis for modeling decisions with regard to housing type (tenure choice) and introduces the variables used in the household tenure choice model.

III : Model Formulation and Literature Review

Multinomial Logit Estimation

A multinomial logit model will be used to analyze the data and answer the research questions posed earlier. Multinomial logit is a derivation of the logit model which utilizes the logistic function to model discrete choice applications. Ordinary least squares (OLS) regression was not utilized in the final analysis due to the problems inherent to discrete, limited dependent variable estimation. Using OLS to model a discrete choice situation can result in biased coefficient estimates due to heteroscedasticity, and in a loss of efficiency when compared to maximum likelihood techniques due to the non-normality of the error term (Kennedy, 1985). The maximum likelihood method was used to estimate the tenure choice equation for both renters and homeowners. In this study, multinomial logit was used to simultaneously estimate the coefficients corresponding to the choices of owning, renting, and living in military housing. Living in government furnished quarters was assumed to be the base case for the estimation.

The multinomial logit model produces coefficients that, when applied to the unique characteristics of each family, can be used to determine the probability that a family will choose a given housing arrangement. Equation 1 shows the expression used in the multinomial logit model to evaluate the chance of a family renting or owning a home. The probability that a family will live in military housing is calculated using equation 2 (Kennedy, 1985: 200).

$$\text{Prob [choice } j] = \frac{e^{\beta x_{ji}}}{\sum_j e^{\beta x_{ji}}} , j = \text{homeowner, renter} \quad (1)$$

$$\text{Prob [on base]} = \frac{1}{\sum_j e^{\beta x_{ji}}} , j = \text{homeowner, renter} \quad (2)$$

Equations 1 and 2 are also used in the sensitivity analysis section of this thesis. It is interesting to note that the multinomial logit coefficients can be used to both estimate the probabilities that a particular family will choose each housing alternative, and, when used with sample means, can also be used to predict the proportions of families that will choose each housing alternative. The equation can be applied both to the individual family, as well as at the aggregate level.

Independent Variable Selection

Each family faces the question of whether they should rent or own a home. This decision has many facets, a few of which are financial in nature. A family's demographics, along with the relative financial attractiveness of each housing choice affect their decision. Many studies have been performed modeling the rent versus own decision (also known as the "housing tenure choice decision"). However, none have simultaneously studied the three housing decisions facing military families (to own, to rent, or to live in military housing). Literature on tenure choice is used to suggest relevant variables to be included in the military housing choice model. The independent variables included in the model address the following considerations:

Officer / Enlisted. The military rank structure distinguishes between officers and enlisted personnel in many ways. Officers and enlisted members have differing pay

scales, promotion systems, educational opportunities, and housing areas. Military housing is segregated into officer and enlisted areas and separate waiting lists are maintained for each class. These factors, along with many others, place officer and enlisted families in separate categories and necessitate the inclusion of an indicator variable distinguishing officer from enlisted families.

Service Identifier. The different branches of the military have different housing situations and operational requirements. Therefore, indicator variables for branch of service are included in the model.

Racial and Ethnic Differences. Studies have found that a family's race and ethnicity affects their housing choice (Goodman 1996). This study includes indicator variables for both Black race Hispanic ethnicity. Past studies confirmed that households with minority heads spend less on housing (Camm: 40). Given the present anti-discrimination climate of the armed services, the variables for Black and Hispanic will be included to investigate whether minority status has an effect upon the decisions of American military families.

Crime Rating. Military housing, unlike civilian neighborhoods, exists within controlled, government secured housing areas. Because crime rates in potential civilian housing areas may influence housing choice, a variable measuring the perceived the crime in surrounding civilian areas is included in the housing decision model.

Military Housing Availability. The availability of military housing directly affects the waiting time for military housing. Therefore, the availability of military housing is included in the housing choice model.

Civilian Housing Availability. A variable measuring the perceived availability of civilian housing is also included in the model.

Total Dependents. Family size has been used as a predictor variable in many housing tenure choice studies (Camm, 1990: 33) (Haurin, Hendershott, and Kim 1994). In general, it has been found that, when all other variables are held constant, as a household grows larger, the tendency to own a home increases (Camm ,1990: 40).

Household family size is of added importance in the case of military housing due to the method the Department of Defense uses to allocate family housing units. The number of bedrooms that each family needs is determined by the local military housing office. This determination takes into account both the member's military rank and the number of dependents a member has. Families with more dependents are allocated units with more bedrooms. Because waiting lists for government housing are segmented by number of bedrooms, families with differing numbers of dependents could have considerably different wait times for housing. The number of dependents may both affect the tendency of a family to own a home, as well as the tendency to live on or off base.

Income & Wealth. Income has been shown to be strongly correlated to home ownership (Camm: 33). As income rises, the ability to make required down payments and the ability to qualify for a mortgage both increase. The interest deduction for a mortgage is more attractive to a family with a larger income and corresponding higher marginal tax rate. The use of income in tenure choice decision models also reflects the correlation between income and overall household maturity. As a household becomes more mature, they tend to save more and to focus more on the dwelling which they

occupy (Camm, 1990: 34). Haurin, Hendershott, and Ling (1988) suggest that increased income is related to an increased desire for the privacy of an owner-occupied home.

The wealth of a household has been correlated with home ownership (Kamara, 1994). As the family accumulates wealth and a positive net worth, their ability to own a home increases as does a home's financial attractiveness as an equity building tool. A family's financial ability to purchase a home is dependent on both the family's ability to secure an adequate down payment and its ability to qualify for the mortgage.

Military personnel qualify for Veteran's Administration (VA) guaranteed home loans. VA loans are attractive to lenders because a certain portion (up to \$50,750), is guaranteed by the government (Electronic Correspondence : Veterans Administration , 5 May 1997). This guarantee alleviates the need for a down payment and also makes a mortgage to a military family more attractive to a lender. Because of this and as well as the strong correlation of wealth and income, wealth is not included in this study.

Tenure Choice User Cost. The decision to buy a home is affected by the investment and consumption aspects of home ownership relative to the alternatives of renting or living in military housing. Hendershott, in his 1982 paper on tenure choice, provides a framework for assessing the actual annualized cost of owning a home. This cost is calculated considering factors uniquely relevant to home ownership. These factors are; the tax deductibility of mortgage interest, expected house price appreciation, depreciation of the physical house structure, closing costs, property tax rates, mortgage interest rates, and the purchase price and rental cost of constant quantity / quality housing

units in the local area (ACCRA, 1993)². The user cost equation suggested by Hendershott and Shilling in their 1982 paper (Hendershott, 1982: 4) is used to control for the relative cost of owning versus renting for housing of equal size and quantity (appendix A).

Ideally, the housing choice equation used in this research should account for the cost of owning a house relative to the cost military housing, and the cost of renting relative to the cost of military housing. Unfortunately, no information is available to adequately control for variations in military housing size and quality at different locations.

This chapter has discussed considerations related to the construction of the estimation model. The next chapter describes the sample data and variables in detail.

² The relevant price indexes for owning and renting for specific areas were drawn from the ACCRA Cost of Living Index (ACCRA, 1993).

IV : Sample and Variable Description

Data

The data are from the 1992 Surveys of Officers and Enlisted Personnel and Their Spouses (Defense Manpower Data Center, 1992). The survey reports many characteristics of military men and their wives including education, total number of dependents, military rank, years in service, military income, civilian income, family wealth, and the type of housing the family occupies. The survey also reports both the military members' and the spouses' attitudes towards their housing, the local area, and the military. Each member answered questions pertaining to how long they have been at a location, as well as their time remaining at the present base. The sum of the two variables equals their expected tour length.

Sample Selection. Responses for expected tour length were used to eliminate all observations reporting tour lengths of either less than one year or more than four years. Members who expect a tour of less than one year are most likely in a training status or on special assignment, and members planning to remain in a single location for more than four years also represent special circumstances³. Because of the sometimes lengthy waits for military housing, all families that have been at a location for less than a year were eliminated from the data. It is assumed that a family would have been able to secure

³ Initial tour lengths in excess of four years are uncommon. Individuals with tour lengths greater than four years have most likely received a subsequent assignment at the same location. Usually, such subsequent assignments cannot be confidently predicted when first assigned and therefore they may not have affected the initial housing decision.

government housing within the first year at a duty station, if that is the housing choice of the family.

Military members who have served for more than 20 years and those serving less than one year were excluded. Members serving more than 20 years are generally older and higher ranking, and as such their housing choices may be less representative of military families in general. Personnel serving less than one year are excluded because they are still becoming familiar with the merits of their possible housing choices.

Observations that did not answer all the questions needed to construct the variables in the housing choice equation were deleted. The equation estimation requires that values for all variables be present in every observation included in the study.

The above restrictions yielded a data set of 1,050 observations. All officer and enlisted ranks were present except for the rank of E-1 and all ranks above O-6. The absence of E-1 data is not of primary concern given that military members usually remain at the rank of E-1 for only a short period of time before being promoted, and that E-1s are generally only in training at a location for a limited time. Ranks greater than O-6 represent general officers. There were no general officers in the data set used, but if there had been, they would have been rejected as not representative of the typical military family. Less than two percent of military people serve in the rank of E-1 or above the rank of O-6 (Defense Manpower Data Center; March 1997).

Weighting the Data. The data that were used for the OLS and multinomial logit estimations were subject to some sampling bias. For instance, only families that gave an opinion with regard to the availability of military housing were included in the data set. This led to the inclusion of a much larger percentage of government housing residents

than actually reside in government quarters. It was also apparent that the percentage breakout of services and military ranks within the sample was not representative of the actual demographics of today's military.

The procedure used to weight the data consisted of two steps. In the first step, the data were weighted to be proportionately representative of the actual 1997 rank and service distribution of married couples residing in the United States (Defense Manpower Data Center). The second step in the weighting process was to weight the sample to be proportionate to the actual 1997 distribution of on base, renting, and home-owning couples.⁴

Variable Description

The equation used to study housing choice is as follows:

Housing Choice = f (Officer, Army, Navy, Marine, Hispanic, Black, Crime Rating, Military Housing Availability, Civilian Housing Availability, Number of Dependents, Spouse's Income, Member's Income, User Cost, Tour Length).

The independent variables will be discussed in-turn.

Officer / Enlisted (Officer). An indicator variable is included in the housing choice model that distinguishes officer and enlisted families. The variable is 1 if the military member is an officer and 0 if the military member is enlisted. This indicator variable allows the housing choice equation to capture group differences between officer

⁴ In the first step, the data was segmented into groups of similar rank and service. This segregated data were then compared to the actual service demographics of March, 1997, and a weighting factor was developed. The data was then segmented solely by housing status and weighted accordingly. When multiplied together, the weighting steps effectively cause the data to perform as a representative sample from the March, 1997 military population.

and enlisted families. The unweighted data set is 57.6% officer families with the remainder being enlisted.

Service Identifier (Army, Navy, Marine). Three indicator variables were included to account for differences in housing choices attributable to membership in a specific service. Army, Navy, and Marines all have indicator variables assigned, while the Air Force is considered the base case. All services are represented with the largest number of respondent coming from the Air Force (367 of 1050). Table 3 shows the number of respondents in the unweighted data from each service.

Table 3: Number of Families in Each Service

Army	227
Navy	295
Marines	161
Air Force	367
Total	1050

Racial and Ethnic Differences (Latin, Black). Indicator variables were included in the logit equations for both Hispanics and Blacks. Within the unweighted data, 6.3% were Black, and 6.2% were Hispanic.

Crime Rating (Crime). The crime rating variable used in this study is based on the respondent's answer to a subjective question of how much crime there is in the local area. The question states, "How much of a problem is each of the following at the location where you live : Crime (Defense Manpower Data Center, 1992: 4)." The responses were based on a scale of one to four, with a response of one representing a response of *Not a Problem* and a four representing a *Serious Problem*. The mean response was 2.72 which is between a *Slight Problem* and *Somewhat of a Problem*.

Military Housing Availability (Military Housing Avail.). The military housing availability rating variable used in this study is based on the respondents answer to a subjective question regarding their feelings toward the community in which they reside. The question states, "The next question is about your feelings about the location where you live now... Location characteristics: Military Housing Availability (Defense Manpower Data Center, 1992: 2)." The responses were on a scale of one to five with a response of one representing a response of *Very Poor*, a two *Poor*, a three *Fair*, a four *Good*, and a five representing *Excellent*. The mean response was 2.17 which is between a *Poor* and *Fair*.

Civilian Housing Availability (Civilian housing Avail.). The civilian housing availability subjective rating is based on the respondent's answer to a subjective question regarding their feelings towards their community. The question was asked as part of the same set of questions which asked about military housing availability and is measured with the same scale. The mean response was 3.16 which is above *Fair* but below *Good*.

Number of Dependents (Number of Dependents). The number of dependents a family has can affect its demand for differing housing types. The value for the number of dependents does not include the spouse and had an average of 1.64 dependents. Table 4 shows the number of families with each number of dependents used in the data set.

Table 4: Number of Dependents in Military Families

Total Number of Dependents	Frequency
0	196
1	227
2	398
3	158
4	50
5	7
6	2
7	1
8	1
9	0

Spouse's Income (Spouse's Income). The income of the spouse is an important variable considered when a family decides which housing to occupy. The average spouse's income was \$6,110, with a standard deviation of \$8,370. Four hundred and seventy-seven spouses did not work, and the majority earned less than \$10,000 per year. These low earnings could be explained by the military lifestyle. In his 1996 paper, Professor Gill explains that military wives, on the average, earn less than their civilian counterparts due to a number of factors. In particular the spouses of military members were less likely to be employed, and when employed, have less job tenure than their civilian peers. The distribution of spouses' incomes is shown in table 5.

Table 5: Spouse Income

Spouse Income \$	Count
0	477
0 to 5000	197
5000 to 10000	128
10000 to 20000	176
20000 to 30000	48
>30000	24

Military Member's Income (Member's Income). Military income is calculated as a sum of the taxable military income and civilian earnings and the taxable equivalent of military allowances. As stated earlier, when a military family chooses to live in government quarters, they lose all housing allowances. Therefore, the amount lost in housing allowances is the opportunity cost to a military family living on base. Military allowances for both subsistence and housing are not taxable. In order to adjust these allowances to their taxable equivalent, they were increased by 20% prior to being added to taxable military income. Additionally, if a family lives on base, BAQ was added to their income in the amount listed in the 1992 military pay tables (see table 2). Because the VHA on base members would receive if they lived in private housing was not known, VHA for them was estimated as a function of the locality characteristics identified in the data set. The equation used can be found in appendix B. The addition of VHA and BAQ to the income of families in military housing standardizes income to the amount that the family would earn if they were to live in private quarters, and therefore accurately reflects the opportunity cost of living in government quarters. After these corrections were made, the mean income for military members was \$31,140, with a standard deviation of \$13,700.

Tenure Choice User Cost (User Cost). Tenure choice user cost is calculated using the equation contained in Appendix A. This equation requires that the locality of the respondent be known because it uses locality specific owner and renter price indexes. Respondents' locations were identified by matching VHA paid with locality VHA rates.

Because on base personnel do not draw VHA, this approach could not be used to identify their locality. The alternative approach adopted was to estimate the entire user cost term as a function of known respondent and location characteristics. The equation has an adjusted r-squared value of .33 and can be found in Appendix C.

This chapter discussed the data set that was used as well as the variables that are used in the housing choice model. The following chapter constructs the model and reports results.

V: Results & Sensitivity Analysis of Policy Variables

Housing Choice Equation Results

Multinomial logit was used to construct a model of housing choice. Table 6 compares the predicted choices from the model with the actual housing choices. The choice which is found to have the highest probability is identified as the predicted choice of the respondent. When the probabilities are calculated for the *average* respondent, the predicted probabilities approximate the actual percentages of on base, renter, and owner couples in the 1997 military.

Table 6: Housing Choice Model Predictions

		Predicted			
Actual	On Base	On Base	Rent	Own	Total
	Rent	352	80	100	532
	Own	58	104	88	250
	Total	43	24	201	268
		453	208	389	1050

Variable Findings

Table 7 shows the results from the estimated equation. As mentioned previously, the multinomial can be used to estimate the probability of renting and the probability of owning. The probability of living in military housing is not separately estimated because it is equal to one minus the probability of renting or owning. A positive coefficient indicates that increases in that variable increase the probability that the family will choose the corresponding alternative. In assessing the impact of a variable on choice

probabilities in the following discussion, all other variables in the equation are evaluated at their mean values.

Table 7: Housing Choice Model

Variable	<u>Rent</u>		<u>Own</u>	
	Coefficient	Std Error	Coefficient	Std Error
Constant	2.4671**	0.9156	0.4082*	1.0298
Officer	1.1425**	0.3906	-0.9016	0.3976
Army	-0.5816*	0.2424	-0.3264	0.2433
Navy	0.3821	0.2371	-0.0476	0.2397
Marine	-1.3531**	0.3611	1.350**	0.3820
Hispanic	-0.5871	0.3573	-0.3682	0.3653
Black	0.4469	0.2840	-0.951**	0.3380
Crime Rating	-0.5749**	0.0916	-0.451**	0.0932
Military Housing Avail.	-1.1210**	0.1055	-0.917**	0.1051
Civilian Housing Avail.	0.7249**	0.1137	1.127**	0.1296
Number of Dependents	-0.3525**	0.0796	-0.0290	0.0710
Spouse's Income (\$K)	0.0148	0.0127	0.037**	0.0122
Member's Income (\$K)	-0.0383**	0.0141	0.061**	0.0134
User Cost	0.0350	0.0280	-0.1384**	0.0325
Tour Length (Months)	-0.0005	0.0089	0.0254**	0.0094

Significance at the 1% level is indicated by two asterisks and significance at the 5% level by one asterisk.

Officer / Enlisted (Officer). The coefficient for officer is positive and significant at the 1% level. The coefficient for officer in the equation for owning is not significant.

Service Identifier (Army, Navy, Marine). The indicator variable representing the Marine Corps has significant negative signs for both renting and owning. Results predict that Marines are less likely to rent or own and more likely to live in military housing than members of the other services. Marines are predicted to have a 17.7% probability of renting versus a probability of 32% for the average respondent. For homeownership, the comparable estimates are 19.5% for marines and 33.4% for the average respondent.

The coefficient of the indicator variable for the Army is significant at the 5% level for renting . Compared to the average respondent, Army personnel are predicted to have an 24.6% probability of renting versus the average probability of 32%.

Racial and Ethnic Differences (Latin, Black). The only significant effect (at the 1% level) attributable to racial and ethnic differences pertains to Blacks. Based on the significant negative coefficient in the logit equation for homeowners ($p < .01$), Blacks in the data, were less likely to own a home than other races. The calculated probability of home ownership for Blacks was 14.9% for Blacks versus 33.4% for the average respondent. No significant differences were found for Hispanics.

Crime Rating (Crime). As hypothesized, the amount of perceived crime in an area affects housing choice. Possibly because of the increased security on military installation, the more crime perceived to exist in an area, the less likely families are to live in private housing (either rent or own). The logit equation shows a significant negative sign on both coefficients for renting and owning a home. As the perceived crime level increases, the percentage of families choosing to live on base increases (see table 8).

Table 8: Actual Unweighted Responses for Crime

	Crime Rating			
	Not a Problem	Slight Problem	Somewhat of a Problem	Serious Problem
On Base	35.0%	42.7%	50.5%	63.8%
Renters	39.8%	25.0%	24.0%	14.4%
Homeowners	25.2%	32.3%	25.5%	21.8%

Further analysis also shows the effects of crime on housing choice. With the other variables assuming their mean values, the percent on base if crime is rated as a serious problem (rating of 4) is predicted to increase from 34.7% to 50.4%. Likewise, crime was rated as not a problem (rating of 1) the percentage predicted to live on base would decrease to 17.9%.

Military Housing Availability (Military Housing Avail.). The perceived level of military housing availability significantly negatively affects both the probability that a family will rent, and the probability that a family will buy a home. As military housing becomes more available, more families will choose to live on base. This relationship makes intuitive sense.

With the other variables assuming their mean values, the percent on base if military housing availability is rated as very poor (rating of 1) is predicted to decrease from 34.7% to 13.8%. Likewise, if military housing availability was very good (rating of 5) the percentage predicted to live on base would increase to 90.1%.

The perceived military housing availability differed between the services. The mean responses for military housing availability are shown in table 9.

Table 9: Weighted Mean Military Housing Availability by Service

	<i>Army</i>	<i>Navy</i>	<i>Marines</i>	<i>Air Force</i>
Military Housing Availability	2.05	2.01	2.38	2.37

Civilian Housing Availability (Civilian Housing Avail.). Perceived increases in civilian housing availability significantly (at the 1% level) increased both the probability

of a family renting or owning. The greater the availability of civilian housing alternatives, the less likely a family is to choose the government housing option.

With the other variables assuming their mean values, the percent on base if civilian housing availability is rated as very poor (rating of 1) is predicted to increase from 34.7% to 78.2%. Likewise, if civilian housing availability was very good (rating of 5) the percentage predicted to live on base would decrease to 8.2%.

Number of Dependents (Number of Dependents). The number of dependents in a family significantly (at the 1% level) and negatively affects the tendency of the family to rent. This may be attributable to the limited availability of larger rental properties. It may also reflect an assignment policy to military housing which benefits larger families. Members of the same rank who have bigger families are assigned to larger houses. With the other variables assuming their mean values, the percent on base if the number of dependents per family was decreased to one is predicted to decrease from 34.7% to 18%. Likewise, if each family had four dependents, the percentage predicted to live on base would increase to 50.4%.

Spouse's Income (Spouse's Income). The coefficient of spouse income is significant at the 1% level and suggests that the extra income brought home by a the spouse will contribute to the probability that the family will choose to own. If a spouse were to work in the local community, it may be much more attractive to the family to buy a home that is close to both the military installation and the spouse's employment. A military family with a non-working spouse may be less financially independent and more likely to live on the military installation to save on housing and transportation costs. Indeed, when it is assumed that all other independent variables are held constant, and that

a spouses will receive no income, the predicted percentage of families living in government housing increases from the current level of 34.6% to 38.3%.

Military Member's Income (Member's Income). The income that the military member earns significantly affects (at the 1% level) both the tendency to rent (negatively) and own (positively). The more income that a member earns, the less likely his family is to rent and the more likely to buy a home. This relationship suggests that changes in military income, which are directly controllable by the government, will change the housing choices of military families. If all independent variables in the logit model are held constant except for military income, a variation of military income by only ten percent results in predictions of the percentage of military families owning a home to range from 28.1% to 39.3%. The percentage predicted to live on base ranges from 35.3% (10% decrease in income) to 33.5% (10% increase in income).

Tenure Choice User Cost (User Cost). The tenure choice user cost value based on Hendershott's equation was significant with respect to homeownership. The higher the user cost of owning relative to renting, the less likely a family is to own a home. A 10% increase in the relative cost of owning versus renting is predicted to decrease homeownership from 33.4% to 26%. Concurrently, the percent who rent increases to 32% from 37% and the percent in military housing increases from 34.7% to 37%.

Tour Length (Tour Length). The significant (at the 1% level) and positive coefficient for owning associated with tour length suggests that increases in tour length would increase the probability that a family would choose to purchase a home. The longer that a family lives at a location, the more the closing costs associated with a home purchase can be compensated for by tax and other advantages of owning. When a family

feels more permanently assigned to a location, their tendency to own a home increases as does the financial attractiveness of home ownership. Tour length has an insignificant impact on the probability of renting. The impact of variations in tour length is investigated in the next section.

Potential Effects of Policy Changes

When all the independent variables in the weighted data set is set equal to their mean values, the probabilities associated with the three housing choices is as shown in table 10.

Table 10: Predicted Housing Choices (Base Case)

On Base	34.65%
Rent	31.97%
Own	33.38%

In each of the following analyses, only the policy variable considered in the particular analysis will be varied. All variables not being analyzed will be held at their mean values.

First Research Question: How would changing military pay affect housing choice? As expected, military income affects the housing choice of military families. In the sensitivity analysis, average military income is decreased twenty percent and is increased by twenty percent.

The results from the income sensitivity analysis were as expected. When income is decreased, more families will desire the less expensive alternative of government housing. Due to a limited supply of housing, these families, who may no longer be able

to afford to own a home, will turn towards renting. Likewise, if income were to be increased, there would be an increased propensity to own, and less would demand government or rental housing. The effect income variations has on the percent choosing each housing alternative is shown in Figures 3 and 4.

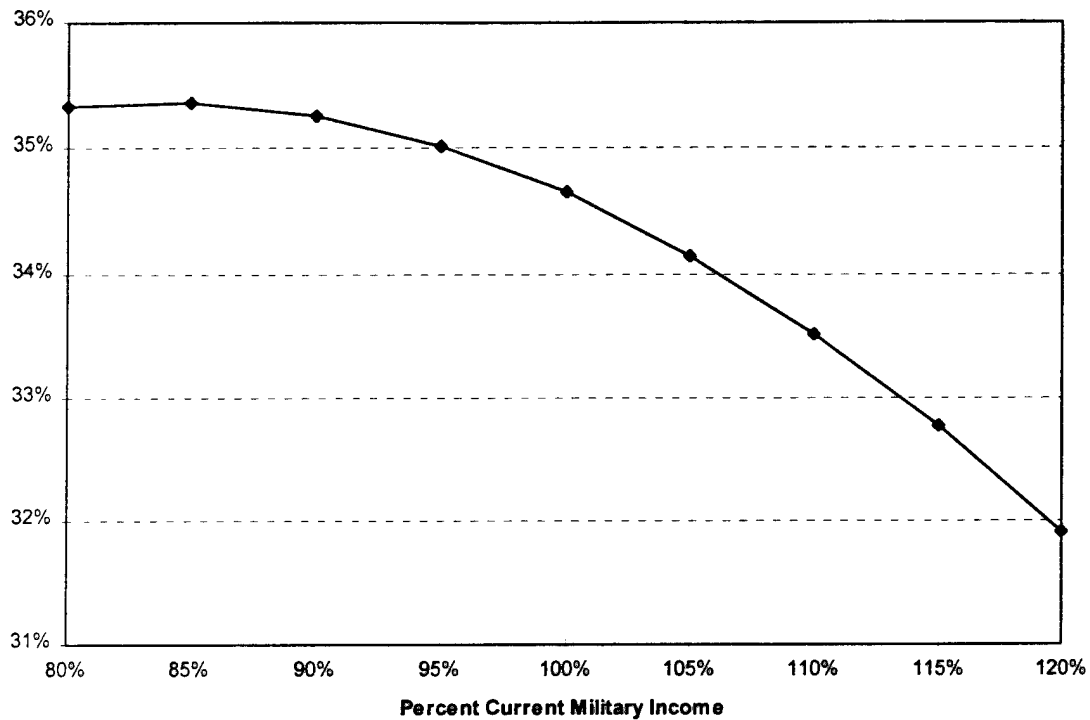


Figure 3: Percent Predicted to Live in Military Housing

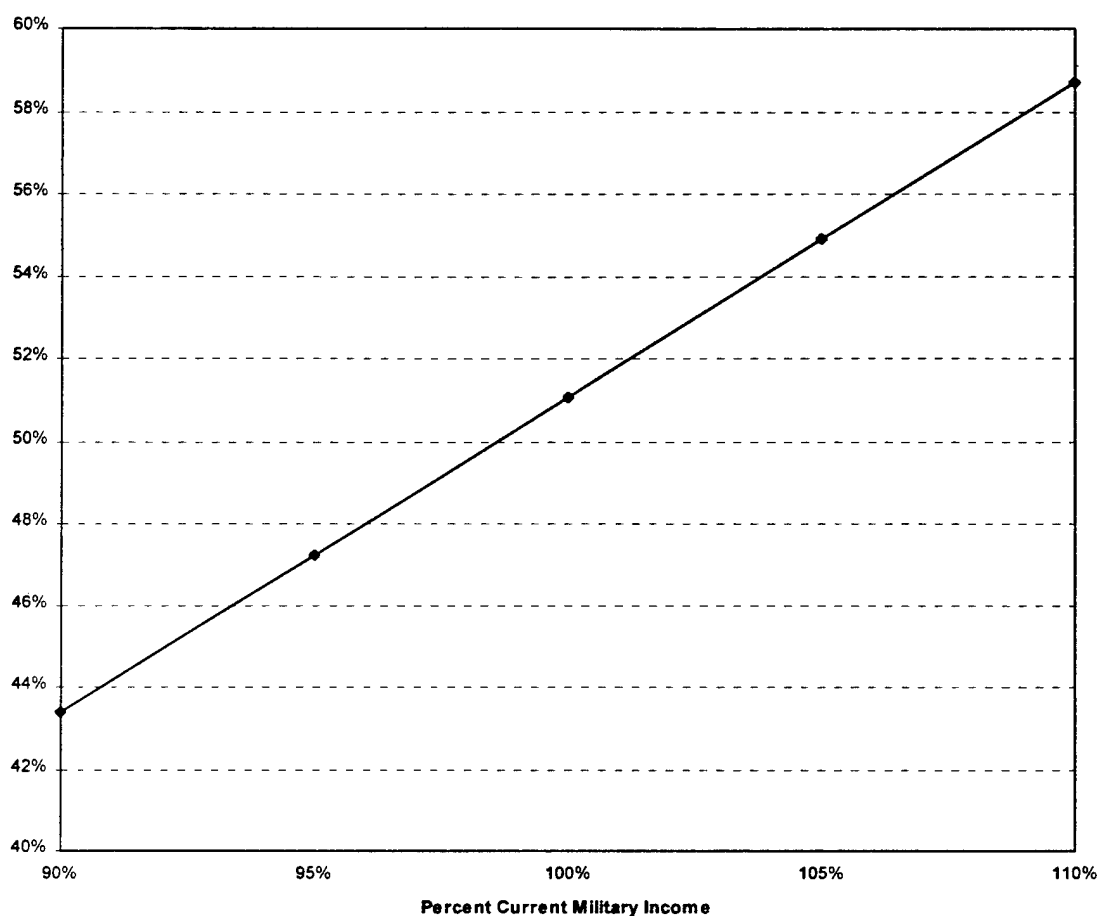


Figure 4: Percent of Personnel Living In Private Housing Predicted to be Homeowners

As income is increased, the percentage of families choosing to live on base is predicted to decrease. This decrease in demand for military housing, coupled with the fact that it is more expensive for the military to housing families in government billeting, would decrease the amount the military would pay for housing. Based on the average military income found in this study of \$31,140, and the GAO projected difference in expenses for military and non-military housing (\$4,957 per family), a 10% increase in military income for the 657,000 military families in the United States would cost 2 billion

dollars and would save 36 million in housing costs per year. Figure 5 shows the projected savings in housing costs associated with increases in military income.

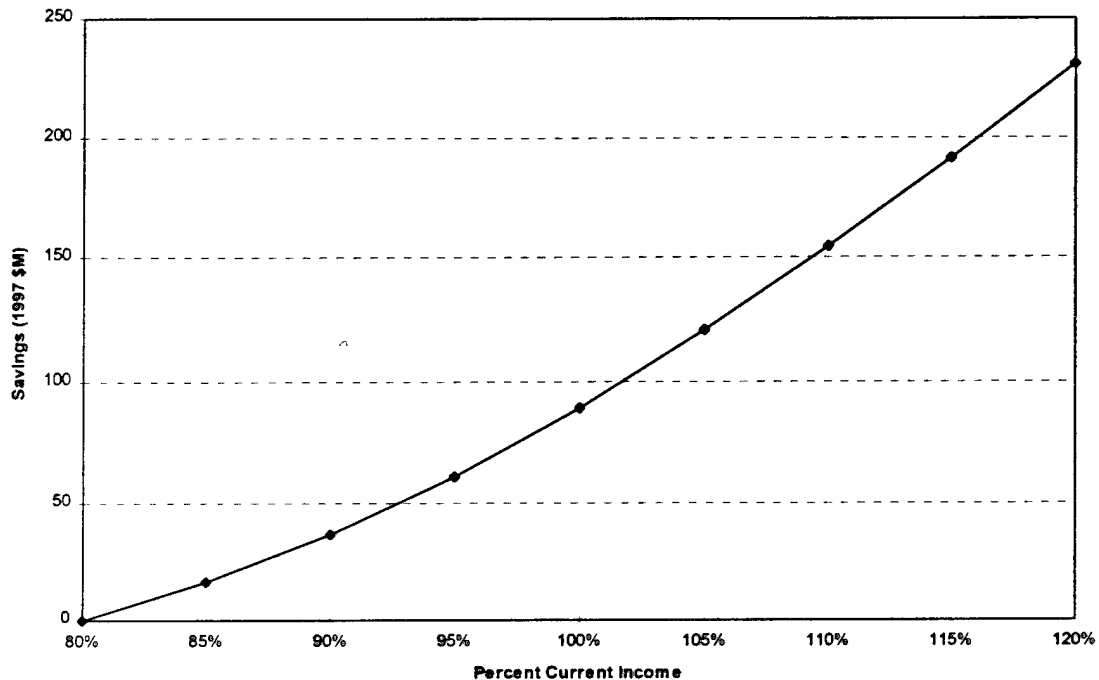


Figure 5: Savings in Housing Costs

Second Research Question: What effect on housing choice would changing tour length have? Tour length affects the housing decisions of military families in a manner similar to military compensation. An increase in tour length raises the number of homeowners. A decrease will have the opposite effect; owning will decrease while renting and living on base will become more prevalent. The results of the sensitivity analysis conducted on tour length are shown in figures 6 and 7.

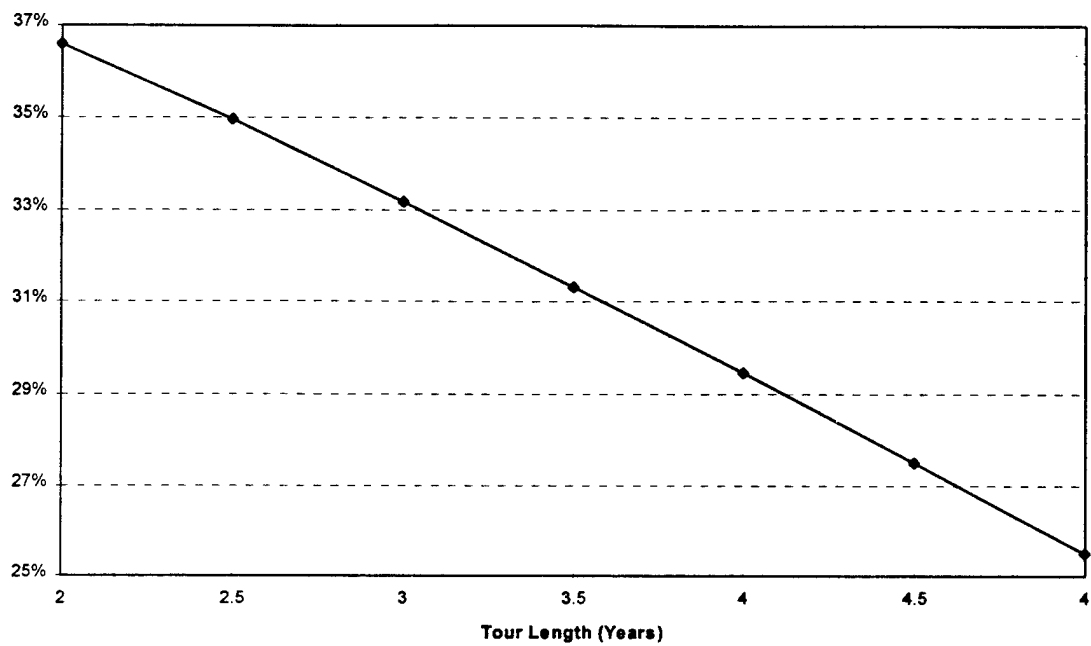


Figure 6: Percent Predicted to Live On Base

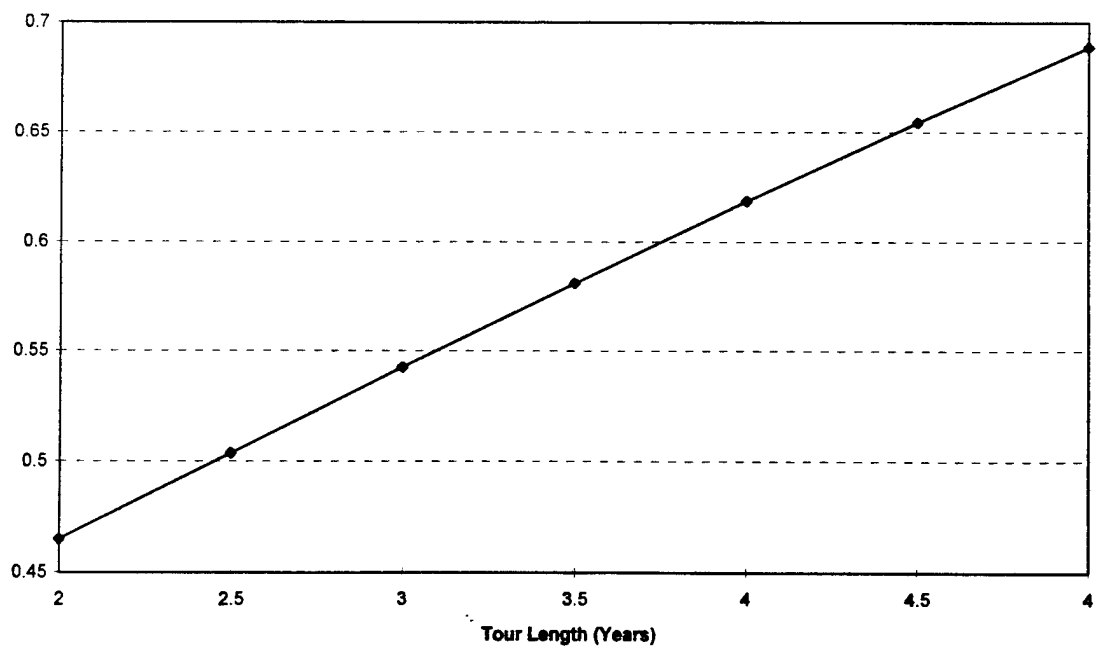


Figure 7: Percent Living Off Base Predicted to be Homeowners

As tour length increases, the percent of military families that choose to own a home increases. The added stability of a longer tour, combined with the increasing financial attractiveness of owning when in a location for longer periods of time, combine to make the percent that own increase as length of stay increases. The increase in homeowners causes both a decrease in the number of families living in military housing, and the number of families renting. The decrease in demand for military housing could possibly save millions of dollars. The results from the sensitivity analysis, when multiplied by the number of military families in the United States, produces the number that will actually choose each alternative (March 1997 figures). Table 11 contains the results from this analysis.

Table 11: Families' Housing Choices (Tour Length Sensitivity)

# Families (K)	<u>Tour Length (Years)</u>					
	2	2.5	3	3.5	4	4.5
On Base	240.6	229.7	218.1	206.0	193.4	180.6
Rent	222.8	212.0	200.7	188.9	176.9	164.6
Own	193.7	215.4	238.2	262.1	286.7	311.8

From this table, one can see the difference that a change in tour length would have on housing choice. Increasing the length of the average tour by only one year from the weighted sample average would make 23,900 families choose to move out of government housing and would increase the number of homeowners in DOD by 47,100. The savings

to the Department of Defense associated with increased tour lengths can be substantial.

Table 12 shows the savings the military might realize by increasing tour length.⁵

Table 12: Projected Savings

<u>Tour Length Increase (Yrs)</u>	<u>Savings (\$ Million)</u>
0.5	57,832
1	118,298
1.5	180,786
2	244,600

Third Research Question: What impact would eliminating transaction costs have on housing choice? As previously mentioned, the large transaction fees associated with selling a home present an obstacle to military families owning homes. The high mobility of the military lifestyle increases the importance of transaction fees normally associated with owning a home. In order to estimate the effects transaction fees have on the housing choice, an additional multinomial logit model was required.

Hendershott's simple user cost equation does not model the transactions costs associate with user cost. However, he proposes a more complex user cost formulation in his paper that does include a variable for transaction costs. The complex user cost equation includes interest and depreciation/appreciation rates, expected stay at the location, and the transaction costs associated with buying a home. A typical military family will relocate more often than their civilian counterpart, thus being subjected to more transaction costs. For many military families, the transaction costs will overwhelm

⁵Based on the GAO projected yearly difference in expenses for military and non-military housing of \$4,957 per family. These savings may be substantially greater due to the decreased number of children attributable to less family mobility, and the greater spouse income found for families who move less frequently (Gill, 1996).

any advantages they might experience from buying a home. Using a user cost formula that includes transaction costs enables this study to determine how much removing those costs would affect housing decisions. The full equation can be found in Appendix D.

By inserting the mean of the relative cost variable evaluated with no inherent transaction costs into the logit equation established using the relative cost variable including transaction costs, an estimate of the effect on housing choice from eliminating transaction costs is attained⁶. Transaction costs could be eliminated if the military were to reimburse real estate and homeowner selling costs in the same way that it currently reimburses other moving costs.

The results from this analysis were convincing. If transaction costs were negated, 59.2% of military families would choose to own as compared to the current 32.4%. This increase is an 82% relative increase in the number owning. The costs of this program are estimated at 3.4 billion dollars,⁷ and the savings in military housing costs are estimated at 2.3 billion dollars over the average tour length⁸.

⁶ For on base personnel, it was necessary to estimate the mean values of the user cost term for the case of transaction cost and the case of no transaction costs. The equations are in Appendices

⁷ Calculated using transaction costs equating to 8% of the average house values for the sample (\$109,700).

⁸ Calculated using GAO projected average yearly savings of \$4,957 over the average tour length of the sample (2.6 years). Avoided renovation costs could possibly significantly increase savings. Retention would likely increase due to the positive effect of lower mobility on spouse earnings (Gill, 1996). Increased spouse income may also actually increase corresponding to longer tours and less family mobility.

VI : Conclusions and Policy Recommendations

Recommendations

The results of the previous section suggest that the American military consider lengthening the average tour. Increasing tour length can save millions of dollars each year in military housing costs. Along with the savings resulting from decreased housing costs, moving and re-training expenses may also be reduced if the Department of Defense were to lengthen the average length of stay in a location. The results also suggest that two thirds or more of the cost of reimbursing real estate transaction costs could be recouped by savings in military housing costs. Increases in military income, apart from beneficial impacts on force quality and retention, would also induce significant savings in military housing expenditures.

Future Research

This research could have benefited from a measure of the quantity and quality of military housing actually available to each respondent. Future research should study the effects on satisfaction and retention associated with the type of housing in which military families live. Such analyses would enable an assessment of the benefits as well as the costs of military housing policies to be done.

Appendix A: Hendershott's Tenure Choice User Cost Equation

Variables: (Values in parentheses indicate assumed values for all observations)

τ_y = Marginal income tax rate of the purchaser

i = Mortgage interest rate (.08)

q = Property yearly appreciation rate (.03)

γ_s = Ratio of the price of the structure to the total values of the investment (1)

d = Yearly house depreciation rate (.03)

τ_p = Property tax rate (.02)

R = Ratio of average same quality house price to rent

Tenure Choice User Cost of Owning Versus Renting = $[(1-\tau_y)i - q + \gamma_s d + (1-\tau_y)\tau_p]R$

Appendix B: VHA Estimation

Ordinary least squares regression is used to estimate both VHA for families occupying government housing. In estimating the VHA rate for a family, all variables that could contribute information as to the location of a family are utilized. These included the branch of service, and the military pay grade of the member. In addition to demographic variables, distance to population centers is included, as are the amount of crime reported, the cost of living and the availability and quality of civilian housing. Indicator variables are included describing the military member as officer or enlisted and that indicate whether or not the member was Black or Hispanic. The federal tax if the family were to own a home is included as a predictor variable. The model explained over 35% of the variance in VHA rates (adjusted r-square .333), and was highly significant ($p < .01$). Individual variables, their coefficients, standard errors, and respective t-test statistics (in the form of p-values) are presented in table 13.

Table 13: VHA Estimation Equation

Variable	Coefficient	Std. Error
Intercept	90.838	68.406
Rank	31.959**	9.342
Branch of Service	-10.712*	4.672
Member's Age	-4.728*	1.973
Spouse's Schooling	-4.143	2.575
Number of Dependents	-22.050**	4.340
Black	-40.561	25.461
Number of Moves in Military Career	-4.061	3.002
Number of Years Service	3.166	2.316
Distance to Major Population Center	19.653**	5.590
Crime	6.742	5.390
Spouse Income	0.002*	0.001
Officer	-305.317**	107.092
Federal Tax if Own	-0.038**	0.004
Total Income if Own	0.008**	0.001
Civilian Housing Availability	16.888*	7.454
Civilian Housing Quality	-16.007	8.986
Cost of Living	-53.500**	6.405

note: ** = significant at the 1% level

* = significant at the 5% level

Appendix C: Tenure Choice User Cost (No Transaction Costs)

The military families included in the data who live in military housing do not draw VHA and cannot be accurately assigned a geographic location. Since they cannot be assigned a location, the average house and rental prices for their area are not known. An OLS equation is used to assign user costs to these respondents. The equation includes variables that could both explain the respondents' locations as well as the desirability of owning a home. The variables include, among others previously discussed, indicator variables for whether or not the family had child(ren) in the 0-6 or 6-18 age groups and variables indicating the total after tax income the family would earn if they were to rent and if they were to own a home. The results are shown in table 14.

Table 14: Simple User Cost Estimation

Variable	Coefficient	Std. Error
Intercept	226.4262**	0.724
Number of Dependents	0.5719**	0.158
Spouse's Income	0.00003	0.000
Child 0-6 yrs. Old	-0.1234	0.358
Child 6-18 yrs. Old	-0.8997*	0.405
Officer	-0.9558*	0.481
Federal Tax if Owner	0.0005**	0.000
Total Income if Owner	0.0001	0.000
Total Income if Renter	-0.0003**	0.000

note: ** = significant at the 1% level

* = significant at the 5% level

Appendix D: Hendershott's Tenure Choice Use Cost Formula (Including Transaction Costs)

The following equation was used to construct the tenure choice user cost variable for the sensitivity analysis which studied the effects of closing costs (Hendershott & Shilling, 1982).

Variables Defined: (Values in Parentheses were assumed Constant)

γ_s = Ratio of the price of the structure to the total value of the investment (1).

R = implicit rent during the first year.

P = yearly house appreciation (3%).

β = Transaction Costs.

N = Number of years at location.

α = Percent of home purchase price financed (90%).

P_k = Purchase price of the home.

d = Annual house structure deterioration (3%).

p = Expected inflation rate (3%).

i = Mortgage interest rate (8%).

q = Expected housing price inflation (3%).

τ_p = Property tax rate (2%).

τ_y = Marginal income tax rate.

M = Original mortgage term-to-maturity (30 years).

e = Required rate of return.

$$\text{Tenure Choice User Cost} = \left(\frac{e - p + \gamma_s d}{\delta_p} \right) \frac{P_k}{P} \left[1 - \alpha + \frac{(1 - \tau_y) \tau_p \delta_q}{e - q + \gamma_s d} + (1 - \tau_y) \frac{(1 + i)^M \alpha i}{(1 + i)^M - 1} \left[\frac{1 - (1 + e)^{-N}}{e} \right] \right] + \frac{\tau_y \alpha i}{(1 + i)^M - 1} \left[\frac{1 - (1 + i)^N (1 + e)^{-N}}{e - i} \right] + \frac{\alpha (1 + i)^M (1 + e)^{-N}}{(1 + i)^M - 1} - \frac{\alpha (1 + i)^N (1 + e)^{-N}}{(1 + i)^M - 1} - (1 - \beta)(1 - \delta_q)$$

$$\delta_p = 1 - \frac{(1 + p - \gamma_s d)^N}{(1 + e)^N} \quad \delta_q = 1 - \frac{(1 + q - \gamma_s d)^N}{(1 + e)^N}$$

Appendix E: Tenure Choice User Cost (Transaction Costs Assumed 8% House Value)

Complex user cost, as defined by Hendershott, is included in this analysis to facilitate the analysis of the effects of negating transaction costs. The estimation is identical to the simple user cost estimation, except that relative cost using eight percent of the house value as the transaction cost is the dependent variable. The coefficients and individual variable significances of this estimation are shown in table 15. The model has an adjusted r-square of .1621.

Table 15: Tenure Choice User Cost Model: (Closing Costs = 8% House Value)

<u>Variable</u>	<u>Estimate</u>	<u>Std Error</u>
Intercept	35.831**	1.172
Number of Dependents	0.665**	0.256
Spouse's Income	0.00003	0.000
Child 0-6 yrs. Old	-0.659	0.579
Child 6-18 yrs. Old	-1.492*	0.656
Officer	-1.480*	0.780
Federal Tax if Owner	0.001*	0.000
Total Income if Owner	0.0001	0.000
Total Income if Renter	-0.0003**	0.000

note: ** = significant at the 1% level

* = significant at the 5% level

Appendix F: Tenure Choice User Cost (Transaction Costs = \$0)

This equation is used to predict the relative user cost of housing if the government were to pay all transaction costs. The equation has an adjusted r-square value of .2459 and was highly significant ($p < .001$). The coefficients on each individual variable vary slightly from the previous model (see table 16).

Table 16: Tenure Choice User Cost(Closing Costs = \$0)

<u>Variable</u>	<u>Estimate</u>	<u>Std Error</u>
Intercept	25.967**	0.708
Number of Dependents	0.565**	0.155
Spouse Income	0.00003	0.000
Child 0-6 yrs. Old	-0.131	0.350
Child 6-18 yrs. Old	-0.865*	0.396
Officer	-0.840	0.471
Federal Tax if Owner	0.0004**	0.000
Total Income if Owner	0.0001	0.000
Total Income if Renter	-0.0003**	0.000

note: ** = significant at the 1% level

* = significant at the 5% level

Appendix G: Logit Estimation Using 8% Closing Costs

The equation below is used to estimate housing choice probabilities in the sensitivity analysis involving military payment of transaction costs. It includes the tenure choice user cost assuming 8% closing costs (actual when available, estimated in appendix E when not).

Table 17: Housing Choice Model (Closing Costs = 8%)

Variable	Rent		Own	
	Coefficient	Std. Error	Coefficient	Std. Error
Constant	2.8957**	0.9875	2.1142	1.1138
Officer	1.1058**	0.3888	-0.9996*	0.4009
Army	0.7200**	0.1136	1.1281**	0.1301
Navy	-1.1243**	0.1059	-0.9393**	0.1063
Marine	0.0098	0.0198	-0.1333**	0.0239
Hispanic	0.0049	0.0096	-0.0025	0.0104
Black	0.3930	0.2838	-0.9615**	0.3407
Crime Rating	-0.5971	0.3570	-0.3210	0.3651
Military Housing Avail.	-0.5509*	0.2415	-0.3046	0.2446
Civilian Housing Avail.	0.3922	0.2383	-0.0709	0.2417
Number of Dependents	-1.3418**	0.3609	-1.3690**	0.3870
Spouse's Income (\$k)	-0.5728**	0.0919	-0.4467**	0.0934
Member's Income (\$K)	-0.0406**	0.0139	0.0648**	0.0133
User Cost (8%)	0.0134	0.0126	0.0383**	0.0122
Tour Length (Months)	-0.3476**	0.0790	-0.0086	0.0719

Significance at the 1% level is indicated by two asterisks and significance at the 5% level by one asterisk.

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Vita

Lieutenant William R. Forster was born on 4 March 1973 in Ilion, New York. He graduated from Ilion High School in 1991 and entered undergraduate studies at the United States Air Force Academy in Colorado Springs, Colorado. He graduated with a Bachelor of Science Degree in Business Management and was commissioned on 31 May 1995. He was married to his wife, Jennifer, two days later on 2 June.

His first assignment was at the Air Force Academy as a financial analyst for the 10th Air Base Wing. He entered the School of Logistics and Acquisition Management, Air Force Institute of Technology in May 1996.

Permanent Address: 847 Jordanville Road
Ilion, NY 13357

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